Adaptive Sampling And Analysis Programs (ASAPs)

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

Additional approach to sampling program design and execution

Problem:

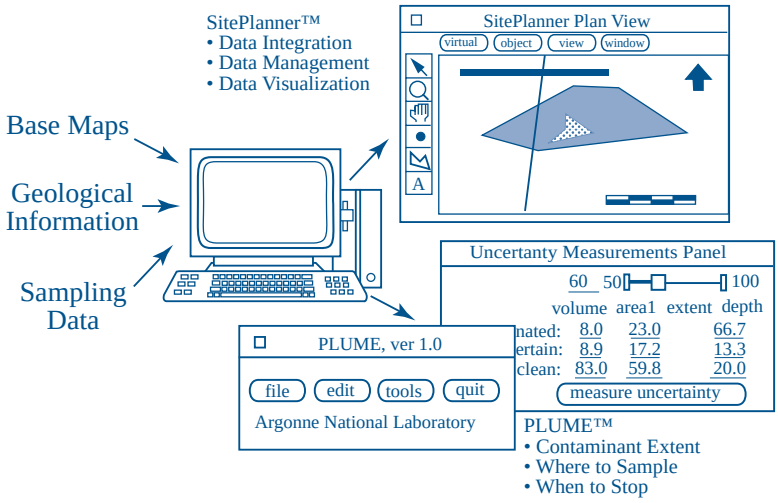
Traditional site characterization methods rely on preplanned sampling programs and off-site analysis of samples to determine the extent and level of hazardous waste contamination. This process is costly and time-consuming. Static work plans specify the numbers and locations of samples to be collected, as well as the analyses to be performed on collected samples. Sampling crews are mobilized, samples are collected, and the crews are demobilized before final results become available. Additional sampling programs are often required to resolve uncertainties raised by the initial sampling and analysis results. The drawbacks of a traditional approach to sampling program design and execution are high costs per sample, pressure to over sample while at the site, and inevitable surprises in the analytical results that require additional sampling programs to resolve.

A key step in the characterization of hazardous wastes at Department of Energy (DOE) sites is determination of the extent of contamination. The proper number and placement of sampling locations is required to both minimize characterization costs, and guarantee that contamination extent can be estimated with reasonable confidence. Because “soft” information (i.e., historical records, computer modeling results, past experience, etc.) for a site are usually just as important as “hard” laboratory results, the approach taken must include a quantitative way of accounting for both “hard” and “soft” site data.

Solution:

An alternative to traditional sampling programs is Adaptive Sampling and Analysis Programs (ASAPs) (OST/TMS ID 2946). ASAPs rely on field analytical methods to generate sample results quickly enough to have an impact on the course of the sampling program. Rather than a static work plan, ASAPs are based on dynamic work plans that specify the logic for how sampling numbers, locations, and analyses will be determined as the program proceeds. To ensure that the sampling stays on track, ASAPs also rely on rapid, field-level decision making. ASAPs require (1) field analytical methods that are appropriate for the types of expected contaminants and media present at the site, and (2) a way of supporting decision making in the field that is appropriate for the goals of the program.

Adaptive Sampling and Analysis Program design and execution.



Optimization of sampling strategies.

ASAPs utilize a dual approach to the sampling strategy problem. First, they use a state-of-the-art object oriented database system that was specifically designed for site assessment work to integrate, manage, and display site characterization data as it is being generated. This package is called SitePlanner™ and was developed by ConSolve, Inc. SitePlanner™ is a graphical, object-oriented database designed to provide qualitative support of environmental site assessments . The system provides site characterization technical staff with as good an understanding of their site data as possible in near real time.

Coupled with SitePlanner™ is Plume™, an interactive software package developed at Argonne National

Solution (Continued):

Laboratory. Plume™ provides quantitative support for adaptive sampling programs. The software merges soft site data with hard sample results to form images of contamination location, provide quantitative measures of the potential benefits to be gained from additional sampling, and indicate the best new sampling locations. Plume™ uses advanced Bayesian and geostatistical procedures to complete these tasks. This approach accepts any existing maps of a contaminated site, borehole log information, field screening data that indicates the presence or absence of contamination at specified locations, and the results from laboratory analyses conducted on soil and/or water samples. The output generated by this approach includes: (1) graphics, such as maps, fence diagrams, and boring logs, that provide characterization staff with a qualitative picture of the extent of contamination and its environmental context; (2) measures of contaminant extent and its uncertainty; (3) estimates of the benefits to be gained by obtaining additional samples; and (4) the best new sampling locations. The most recent developments have focused on integrating these techniques into soil remedial actions to make those actions more precise.

Benefits:

- ASAPs are better than traditional sampling approaches because they provide better characterization. Plume™ can estimate the value that additional sampling data may provide, thus allowing stakeholders to weigh benefits/costs of collecting additional data. SitePlanner™ allows rapid site data visualization as the data is generated.
- ASAPs are faster than traditional sampling approaches: fewer samples are collected and additional field sampling events can be eliminated, resulting in expedited site characterization.
- ASAPs are safer than traditional sampling approaches: worker exposure to contaminants is reduced by fewer field sampling events and fewer samples collected.
- ASAPs are cheaper than traditional sampling approaches: fewer samples are collected thus reducing overall project costs.
- When ASAPs are used to support soil remediation work, a more precise excavation plan can be developed. This reduces overall remediation costs by focusing the work on those soils that truly fail restoration goals.

Demonstrations/Deployments:

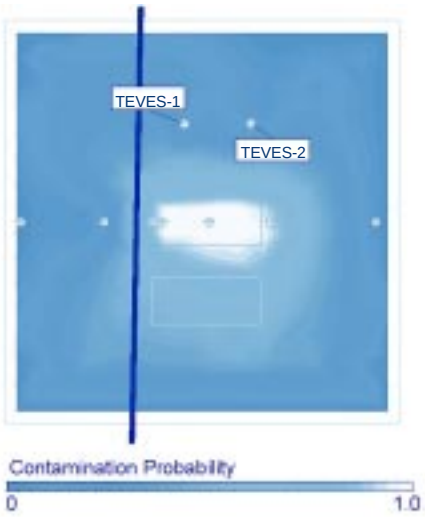
Sandia National Laboratories:

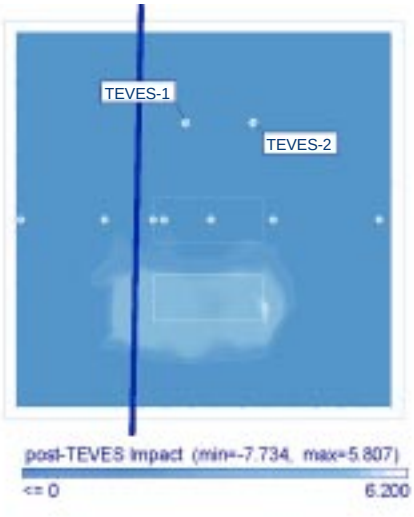
Chemical Waste Landfill, Albuquerque, NM

The problem area was subsurface soil contaminated with chromium beneath the unlined chromic acid pit and the 60s pits. SitePlanner™ and Plume™ were used in a retrospective study to determine ASAP advantages. Field analytical techniques included x-ray fluorescence (XRF).

Benefits:

- The study suggested savings greater than 60% compared to conventional techniques
- ASAPs could provide a reduction in the number of soil bores, samples collected, and overall analytical costs





Kirtland Air Force Base:

RB-11, Albuquerque, NM

The ASAP approach was applied to subsurface mixed waste contamination associated with burial pits at Kirtland Air Force Base. SitePlanner™ and Plume™ were used in a demonstration that was coordinated with actual characterization activities at the site. Field analytical techniques included XRF for metals, a photo ionization detector (PID) for volatile organic compound (VOC) monitoring, and a Geiger-Mueller sensor for detection of radionuclides.

Benefits:

- Cost savings included a 22% reduction for soil borings and a significant reduction in per sample analytical costs
- The number of samples collected was reduced by 50%

Argonne National Laboratory:

317 Area, Argonne, IL

An ASAP approach was used to delineate surface and near-surface VOC soil contamination in the 317 area at Argonne National Laboratory. The purpose of the investigation was to delineate contamination and locate a french drain. The contractor proposed 200 borings and collection of 600 samples from a regular grid. SitePlanner™ and Plume™ were employed in conjunction with field head-space analysis for organics.

Benefits:

- The ASAP reduced the number of borings by 60% and the number of samples by 66%
- The investigation was completed in less than half the time originally specified

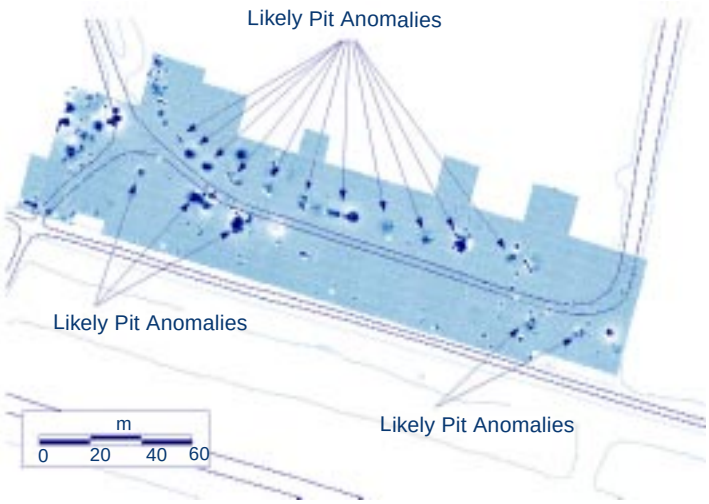
Private Naturally Occurring Radioactive Material (NORM) Contaminated Site:

Mt. Pleasant, Michigan

An ASAP approach was used to delineate surface and near-surface NORM contamination (^{226}Ra). The ASAP was built into the characterization and excavation process. Real-time data collection included gamma walkover combined with GPS, in situ HPGe gamma spectroscopy, and the RadInSoil, an NaI-based in situ system for ^{226}Ra.

Benefits:

- Per sample analytical costs were greatly reduced
- Reliance on soil sampling and ex situ gamma spectroscopy analyses was reduced
- Characterization and remediation activities were combined in one field work cycle
- The remediation effort was more effective with a much more precise excavation footprint



Brookhaven National Laboratory:

Glass Holes Area, Upton, NY

An ASAP approach was used for delineation of subsurface mixed waste contamination including VOCs, metals, and radionuclides. The ASAP purpose was to identify buried waste pits and quantify associated contamination. Field analytical techniques included a suite of nonintrusive geophysics, use of a Geoprobe® for sample collection, and on-site GC/MS for detection of VOCs/semi-volatile organic compounds (SVOCs). SitePlanner™ was used for data display.

Benefits:

- The ASAP provided a much more exact enumeration and delineation of pits
- The estimated reduction in projected cost of pit excavation was on the order of millions of dollars

DOE Formerly Utilized Sites Remedial Action Program (FUSRAP):

Painesville Site, Painesville, OH

An ASAP approach was used for delineation of surface and near-surface mixed waste contamination, including VOCs and radionuclides. The ASAP purpose was to identify and delineate near-surface contamination in support of the Engineering Evaluation/Cost Analysis (EE/CA). SitePlanner™ and Plume™ were used to display data and estimate the extent of contamination. Real-time data collection included gamma walkover combined with a global positioning system (GPS) and on-site gamma spectroscopy.

Benefits:

- Bechtel National, the prime contractor, estimated overall project savings on the order of $10 million. This work received a DOE Pollution Prevention Award

DOE FUSRAP:

Luckey Site, Luckey, OH

An ASAP approach was used for delineation of surface and near-surface mixed waste contamination, including beryllium and radionuclides. The ASAP purpose was to identify and delineate near-surface contamination in support of the EE/CA. Real-time data collection included gamma walkover combined with a GPS, laser-induced breakdown spectroscopy (LIBS) backpack and trailer systems for beryllium, in situ high purity germanium (HPGe) gamma spectroscopy, and on-site gamma spectroscopy.

Benefits:

- There was a reduction in per sample characterization costs
- The use of an ASAP approach resulted in a much more detailed delineation of surficial beryllium and radionuclide contamination

U.S. Army Corps of Engineers (USACE) FUSRAP:

Ashland 2 Site, Tonawanda, NY

Argonne National Laboratory collaborated with the USACE to incorporate the ASAP approach into the excavation process and allow precise excavation of surface and subsurface radionuclide contamination, including ^{230}Th, ^{226}Ra, and ^{238}U. This approach replaced the baseline "block excavation" process. Data collection was performed in real time using gamma walkover combined with a GPS and on-site gamma spectroscopy. The Plume™ software was used for volume estimation.

Benefits:

- The use of Plume™ software resulted in a more precise excavation and reduced off-site disposal
- The USACE estimated that the ASAP approach saved them $10 million

Joliet Army Ammunition Plant:

TNT Production Area, Joliet, IL

An ASAP approach was used for delineation of surface and near-surface trinitrotoluene (TNT), dinitrotoluene (DNT), and nitrotoluene (NT) soil contamination. The ASAP purpose was to delineate contamination in support of a feasibility study. SitePlanner™ and Plume™ were utilized in combination with immunoassay kits and a field gas chromatography/mass spectrometry (GC/MS) system customized for explosives.

Benefits:

- The ASAP reduced analytical costs by 75%
- The ASAP yielded a much more accurate volume estimate for contaminated soils as compared to the capabilities of the gridded approach, which was proposed by the contractor

Currently, deployment projects are underway at Fernald and several other USACE FUSRAP sites including Colonie, Ashland 1, and Linde. All of these projects involve excavation of radionuclide contaminated soils using a combination of real time data collection techniques in an ASAP mode.

Funding for this work originally came from the DOE Office of Technology Development (OTD) [now known as Office of Science and Technology (OST)] through the Mixed Waste Landfill Integrated Demonstration Project. The work began in FY 1992 and continued with OTD support through FY 1994. After FY 1994, there was considerable additional work with support from the Strategic Environmental Research and Development Program and through various DOE offices and Department of Defense Installation Restoration Programs. Most recently, there has been DOE OST support through the Accelerated Site Technology Deployment program for work at the Fernald site, which is focused on integrating ASAP techniques into soil remedial actions. The DOE Office of Fossil Energy is currently sponsoring a technology transfer project for making ASAP techniques more widely available to oil and gas industry NORM problems.

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Or, visit the following Internet sites:

U.S. Department of Energy, Office of Science and Technology
http://ost.em.doe.gov

U.S. Department of Energy, CMST-CP Crosscutting Program
http://www.cmst.org

U.S. Department of Energy, Argonne National Laboratory
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